ence of time between places situated on the surface of the earth; but the distortion grows with increase of latitude, and becomes a maximum in the polar regions, where, however, the departure from the true size and shape of the earth's features is of the least importance for all the usual geographical and physical uses of maps

In the development upon a plane of any non-developable surface, like a sphere, certain errors are, of course, unavoidable; but any of these errors may be diminished, or even made to disappear altogether, at the cost of increasing some other. Thus in Mollweide's projection much has been sacrificed to secure the characteristic condition of strict proportionality between areas on the sphere and the corresponding areas of the projection; and likewise, in Mercator's, other useful attributes have been given up to attain the characteristic condition of the projection, that the track of a ship pursuing the same true course throughout a voyage will be represented by a straight line drawn between the ports of departure and destination.

Van der Grinten's projection appears to be without special characteristics of the kind just referred to, but to have been designed rather with a view of securing a natural and suggestive method of showing the whole world upon a single projection, in such a manner as to convey the idea of its globular form and to represent its main features without violent departures from their true shapes and areas.

THE FLOOR OF THE NORTH ATLANTIC OCEAN.

Sir John Murray has prepared a long paper and a map in which he deals with the "Recent Contributions to our Knowledge of the Floor of the North Atlantic Ocean." The paper is printed as an *Extra Publication* by the Royal Geographical Society.

The author says that the latest additions to our knowledge of the depths of the North Atlantic come from the expeditions of the Prince of Monaco and from several cable ships. The investigations which he takes into consideration are limited to the North Atlantic Basin between Lat. 20° and 60° N., excluding the tributary seas along the margins. The total area dealt with is about 6,875,000 square geographical miles. Between the limits indicated over 70 per cent. of the area of the sea-floor is covered by water

between 1,000 and 3,000 fathoms in depth, about 20 per cent. is covered by less than 1,000 fathoms of water, and 10 per cent. by more than 3,000 fathoms.

The shallow zone, with depths of less than 1,000 fathoms, forms a border around the North Atlantic Basin along the coasts of Africa, Europe, and North America and along the Iceland plateau which joins the British islands with Iceland. This zone includes the continental slope; and soundings have shown in some places what are believed to be submerged river basins or submarine gullies. This shallow zone also surrounds the islands and island groups and also submarine elevations that do not reach the surface. A list of 22 of the more important submarine elevations, or banks, is given.

The area covered by water between 1,000 and 2,000 fathoms in depth is about one-fourth of the total area. It extends along the eastern, northern, and western borders of the map, outside the shallower zone, and also extends uninterruptedly from the northern border down the centre of the ocean as far as the equator. This central ridge or plateau is probably the most striking characteristic in the bathymetry of the North Atlantic Basin. It is very irregular in outline, and is widest in the northern portion, between Lat. 30° and 50° N.

The area of the North Atlantic sea-floor covered by water between 2,000 and 3,000 fathoms in depth is nearly one-half of the total area. This zone forms two large irregular areas—one to the east, the other to the west of the central ridge or plateau. The eastern area extends as far north as Lat. 53° N.; while the western one reaches Lat. 58° N.

The area of the sea-floor covered by more than 3,000 fathoms of water is about $\frac{1}{10}$ of the total area. To these parts of the ocean basins the term "deeps" has been applied, and distinguishing names are applied to them. Sir John Murray briefly describes the ten "deeps" in the order of their size. The Nares Deep is the largest and most important in the Atlantic. Its maximum depth is 4,662 fathoms, and is situated to the south of Lat. 20° N. Within the limits of the area under consideration the Nares Deep covers over 500,000 square geographical miles of the North Atlantic.

From Sir John Murray's description it is evident that the bed of the North Atlantic presents the greatest divergences in its configuration. From the central ridge or plateau, as well as from deeper water, there rise elevations which form islands like the Azores, Madeira, the Cape Verdes, and Bermuda. On the other hand, what are called "deeps" descend about 20,000 feet below

the level of the waves. If the highest mountain in the world were placed in the Nares Deep it would form an island the summit of which would be about 1,000 feet above the water.

In discussing the temperature, salinity, and currents in the waters of the North Atlantic, Sir John Murray says that they present much greater variety and contrast than in any other of the great ocean basins. This arises from the general atmospheric circulation, which drives a large body of tropically-heated water of high salinity into the Basin, chiefly through the Gulf Stream, and at the same time forces a great mass of cold water of low salinity down from the Arctic Ocean. The temperature of the water at the bottom of the North Atlantic Basin in deep water is between 35° and 40° F. over nearly its whole extent. There is higher temperature at the lesser depths and lower temperature at the entrance to Davis Strait and in the Arctic Ocean. The average temperature over the floor of the North Atlantic is about 2° F. above the average temperature at the bottom of the Indian and South Atlantic Oceans; while the temperature of the bed of the Pacific is intermediate between these.

As considerably more than one-half of the area of the land surface of the earth, or about 26,000,000 square miles, drains into the Atlantic Ocean or its tributary seas, it happens that the detritus from rivers and icebergs is more widely distributed over the floor of the North Atlantic than in the other ocean basins.

The rock fragments collected from the sea-bed by the *Minia* and *Faraday* (cable ships) expeditions in 1903 have been carefully examined, and the conclusion is reached that they were transported into the regions visited, between 34° and 50° N. Lat., by ice from Greenland. Some specimens of rock obtained on the *Faraday* expedition were evidently broken off by the dredging apparatus and brought up in the grapnel. The evidence seems to show that most of these fragments were broken from transported boulders. There seems, however, to be conclusive evidence that volcanic rocks of recent origin project above the deposits on the sea-bed in deep water; but as yet there is no trustworthy evidence that any crystalline or stratified rocks project in this manner.

Besides the material transported from the land, there are now forming in the Atlantic great deposits of glauconite and phosphate of lime:

These are being laid down principally along the continental slopes in depths from 100 to 1,000 fathoms, especially along those shores where there is a great annual range of temperature. Glauconite seems to be intimately associated with deposits containing many fragments of continental rocks in process of alteration and decomposition, and phosphate deposits are more abundant where changing physical conditions bring about a great destruction of marine organisms. In the Spring of 1882, it is believed, the sea-bed for hundreds of square miles off the Atlantic coasts of the United States was

covered to a depth of six feet with dead fish and other marine organisms, whose destruction was brought about by the lateral shifting of ocean currents from different sources and of very different temperatures. In all regions of the ocean where similar phenomena take place large deposits of phosphate of lime and glauconite are now in process of formation.

The most striking feature of the deeper marine deposits of the North Atlantic is the large number of calcareous shells which they contain. It is now definitely ascertained that the vast majority in bulk of these calcareous shells belong to animals and calcareous algæ which live in the surface waters of the ocean. These organisms are much more abundant in the warm, salt, tropical waters than in the colder, less salt waters towards the poles and along the continents where rivers pour their fresh waters into the ocean. On the other hand, pelagic organisms which secrete silica for their shells, skeletons, and frustules are more abundant in the colder and less salt water towards the poles and off the mouths of great rivers, where the oceanic water is diluted by water from the land.

The remains of silicious organisms are not sufficiently abundant on any part of the sea-floor of the North Atlantic to form deposits to which the names of Radiolarian ooze and Diatom ooze have been applied. This probably arises from the large amount of detrital matter carried into the North Atlantic on the one hand, and on the other to the large amount of very warm and salt water in all the central parts of the basin.

Until the present time it has been impossible to form even the vaguest estimate as to the rate of the deposition of Globigerina ooze on the floor of the North Atlantic. It is now recognized, however, that a submarine cable is preserved when in contact with this deposit; and the condition of a cable that was lifted by the *Faraday* in 1903 in 2,300 fathoms makes it perhaps fair to assume a period of ten years for the accumulation of a layer of the deposit one inch in thickness at the place where this cable was lifted.

The area of the floor of the North Atlantic between the parallels of 30° and 60° N. Lat. covered by Globigerina ooze is believed to be 60.94 per cent. of the total area; blue mud, 26.76; red clay, 10.80; or a total area for these three deposits of no less than 98.50 per cent. of the area indicated. This leaves an area of only 1.50 per cent. of the total area for the remaining four types represented—viz., green mud, volcanic mud, pteropod ooze, and coral mud. The principal deposit type is Globigerina ooze.

MARINE FOSSILS NEAR THE SOUTHERN EDGE OF THE SAHARA.

Professor de Lapparent's notes on the finding by the French of marine fossils in the Sahara have been referred to in an earlier number of the BULLETIN. The British members of the Anglo-French Commission which in 1903 delimited the boundary of the French and British possessions between the Niger and Lake Chad also